

MAGNT RESEARCH REPORT No. 4  
FEBRUARY 1999

## KEEP RIVER AQUATIC FAUNA SURVEY

HELEN LARSON



Museums and Art Galleries of the Northern Territory



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REPORT TO KINHILL PTY LTD

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# KEEP RIVER AQUATIC FAUNA SURVEY

## REPORT TO KINHILL PTY LTD

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### INTRODUCTION

The fish fauna of the Northern Territory is not yet well known, and there are many gaps in our knowledge (Larson, in prep.; Larson and Williams 1997; Russell and Houston 1989). Northern Territory freshwater fishes and their distribution are better known than marine or estuarine fishes, mostly due to mining interests in the Alligator Rivers region (Larson and Martin 1990). For example, the coastal and freshwater fishes of Kakadu National Park, which includes most of this region, are therefore reasonably well known (Press *et al.* 1995; Larson 1997).

In contrast, the Keep River system is poorly known and its fishes (indeed, any of its aquatic fauna) have never been properly studied. The Keep forms part of the Timor Sea drainage system of the Northern Territory and drains an area of 12,300 km<sup>2</sup> (Midgley 1981). Only three brief *ad hoc* collections of fishes have been made in the Keep River: a three-day sampling of Policeman Waterhole in 1981 (Midgley 1981) and two by the Conservation Commission of the Northern Territory in 1975 and 1980 (based on specimens held at MAGNT). No survey of its estuarine fauna has ever been attempted (Larson in prep.).

A survey of the Keep River aquatic fauna, with emphasis on fishes, was requested by Kinhill, for the Ord River Irrigation Scheme Stage 2. The Stage 2 proposed development includes broadacre irrigation horticultural cropping within the catchment of the Keep River. Irrigation water would be sourced via a new (M2) open channel from the Kununurra Diversion Dam. Additional farm drains and stormwater drains would also enter the Keep. In addition, structural changes such as levees, a bridge and water regulating storage would be included in the development. The development, therefore, has potential for impacts on the Keep River drainage system and its associated biota.

The survey was carried out from 5-11 October, 1998, in the late dry season. The timing and brevity of the survey was constrained by external factors.

## METHODS

Sampling was carried out by two people using multipanel gill-nets, fine-mesh seine, one-person scoop-nets, hook and line (casting rod), dip-net and torch at night, and sight observations. The possibility of Estuarine Crocodiles in the waterbodies prevented snorkeling and visual census methods being used. Sampling sites and methods used were constrained by site access and topology. Upon arrival at a particular locality, most sampling was done with scoop-nets, which resemble small one-person seine nets, for at least an hour (unless the site was plainly depauperate). The scoop-nets, based on a Japanese design, have two handles 1 m long, and multifilament nylon mesh (4 mm knot to knot). If the habitat was suitable, a small fine-mesh seine and gill-nets would be used. Scoop-nets are more efficient among aquatic vegetation than seines.

The two multi-panel gill-nets are each 35 m long, with a drop of 2 m, and seven 5 m long panels each of a different mesh size: 26, 44, 58, 76, 100, 126, and 150, knot to knot. The differing mesh sizes allows sampling of a wide range of fish species and sizes (e.g. from small rainbowfish to adult barramundi). Gillnets were normally set for one hour, to prevent drowning any Freshwater Crocodiles and killing too many fish. Wherever possible, these nets are set so that one is at a right angle to the bank, and one is parallel to the bank (to capture fishes travelling down the centre of the waterbody as well as those moving along the bank close to shelter). The nets are tied or anchored and buoyed so that they remain stationary, and left for approximately an hour in the afternoon, then re-set for another hour in the evening, with sunset occurring during the latter set, where possible.

At night, additional sampling with scoop-nets and small aquarium dip-nets was carried out at each locality. This enables observation and capture of nocturnally-active fish such as eel-tailed catfish, and ease of capture of other species (which may be sleeping).

The seine, scoop-net and dip-net sampling techniques also capture macroinvertebrates such as crustaceans, aquatic insects and molluscs. Terrestrial habitats adjoining watercourses were sampled opportunistically, by hand-collecting and spot-light, for reptiles and amphibians. A range of these organisms were retained for identification.

Specimens were brought back to the Museum and Art Gallery of the Northern Territory, Darwin (MAGNT), sorted and identified, identification confirmed, and deposited as vouchers in the MAGNT reference collection. Specimens deposited in the collection will be registered, and habitat and physical data included in the MAGNT database.

Localities were fixed using a Magellan hand-held GPS. Temperature, salinity and conductivity were recorded by a YSI model 30 system, while pH was recorded using a "Blue Water" test kit. Unfortunately, short notice for the field program prevented the use of a more sophisticated data logger, which was unavailable for the time period required.

On 9-10 October, the intense heat limited work during the day.

Due to circumstances beyond my control, it has not been possible to have the aquatic insects identified in time for inclusion in this report. A separate report on the insect fauna will be prepared.

## COLLECTING SITES

The sites visited are listed below, including habitat and water quality descriptions (and see Fig. 2). Stations are numbered consecutively. Note that the first station is HL 98-35, not 98-1.

**HL 98-35**

Keep River National Park, "Bucket Spring" by northern park border, at small open pool (Fig. 2) in un-named creek fed by spring flowing from escarpment. 15° 44' 47" S 129° 10' 18" E. Water clear, 27.7°C, 0.2 ppt, 425.9  $\mu$ s, 1.5 m deep, current slow. Substrate rocks, sand, rubble, leaf litter and logs. Bright green sponges present on some limestone rocks (Spongillidae, probably *Radiospongilla* sp.). Aquatic vegetation of mixed grasses, reeds (*Eleocharis*), and taro (*Colocasia esculenta*) along edges. Shore steep sandy-clay banks, with few big *Melaleuca*, open woodland behind. 5 October 1998. 0830-1000 hrs. Coll. H. Larson, by scoop-net, hand.



**Fig. 1.** Pool of "Bucket Spring", HL 98-35.

**HL 98-36**

Keep River National Park, "Bucket Spring" by northern park border, at larger open pool (Fig. 3) downstream from 98-35. 15° 45' 00" S 129° 10' 05" E. Water clear, 27.7°C, 0.2 ppt, 431  $\mu$ s, pH 7.6, 2.5-3 m deep, current slow. Substrate rock, loose rocks, leaf litter and logs. Aquatic vegetation of mixed grasses, reeds (*Eleocharis*), and taro (*Colocasia esculenta*) along edges. Shore steep sandy-clay banks, with large *Melaleuca*, open woodland behind. 5 October 1998. 1045-1130 hrs. Coll. H. Larson and P. Horner, by multipanel gill-net.

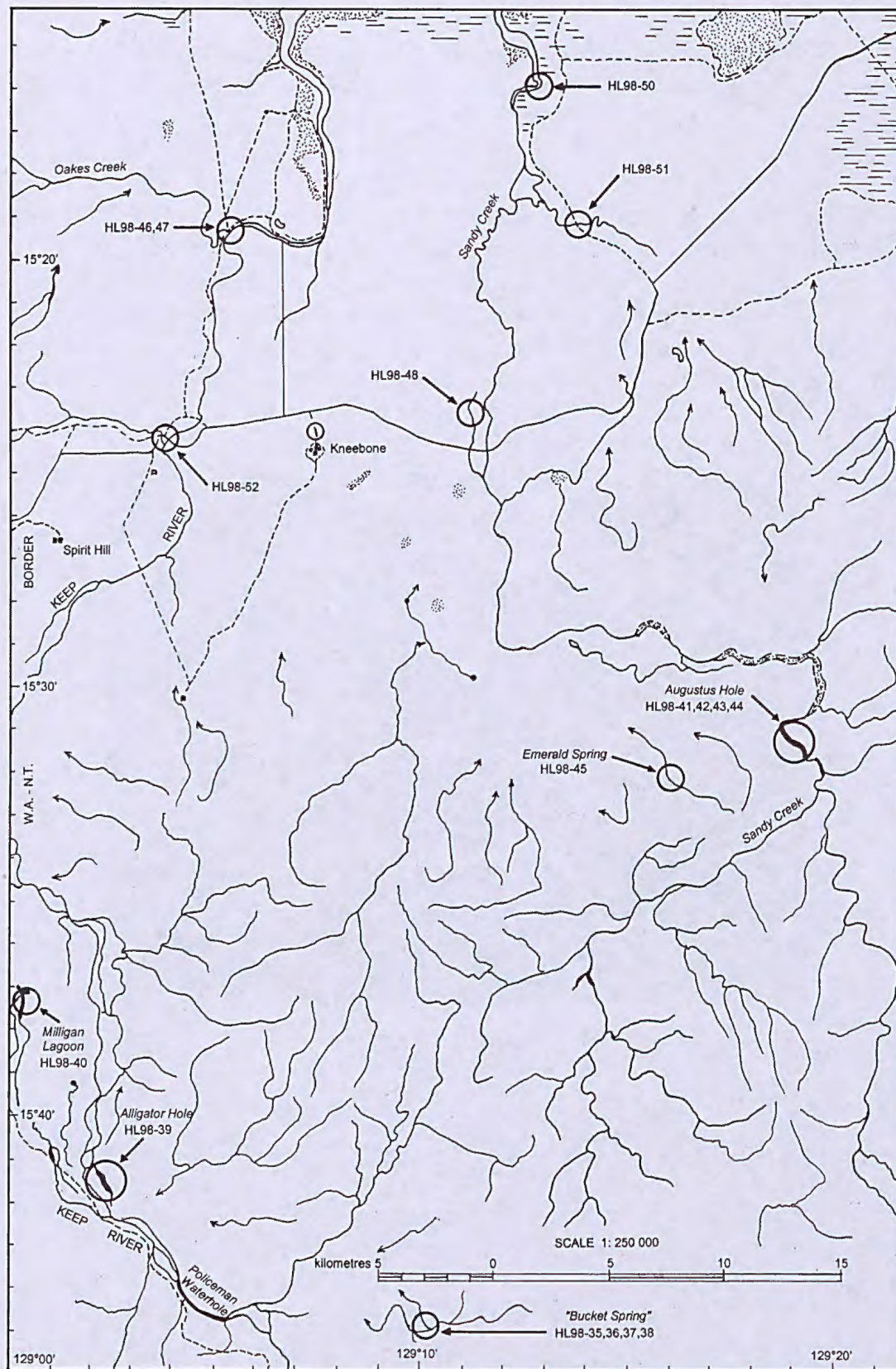


Fig. 2. Map of the Keep River and Sandy Creek area showing localities sampled (circled). Topography other than watercourses not indicated.



Fig. 3. “*Megalops*” pool at “Bucket Spring”, HL 98-36.

#### HL 98-37

Keep River National Park, “Bucket Spring” by northern park border, at very shallow pool (fig. 4) further downstream from 98-36; creek flowing through rush/grass thickets at either end of pool. 15° 44' 58" S 129° 09' 45" E. Water clear, 28.9°C, 433.9  $\mu$ s, pH 7.6, 0.25 m deep, current slow. Substrate sand, leaf litter. Aquatic vegetation reduced; *Marsilea* sp. in water, small amount of reeds (*Eleocharis*), grasses and taro (*Colocasia esculenta*) along edges. Shore sloping sandy-clay banks, with *Melaleuca*, *Barringtonia acutangula* and *Nauclea orientalis*, with open woodland behind. 5 October 1998. 1100-1200 and 2100-2215 hrs. Coll. H. Larson and P. Horner, by scoop-net and dip-nets.



Fig. 4. Shallow sandy pool, “Bucket Spring”, HL 98-37.

**HL 98-38**

Keep River National Park, “Bucket Spring” by northern park border, in deep open hole in “dry” arm of creek (Fig. 5) fed by slow trickle from spring, creek shallow, mostly rush-filled. 15° 44' 59" S 129° 10' 16" E. Water clear, 28.9°C, 475  $\mu$ s, pH 7.6, 1.5 m deep, current slight. Substrate sand, rocks, leaf litter. Aquatic vegetation of mixed grasses and taro (*Colocasia esculenta*) along edges. Shore low grassy banks and low *Melaleuca*, open woodland and escarpment behind. 5 October 1998. 1530-1700 hrs. Coll. H. Larson and P. Horner, by multipanel gill-net.



**Fig. 5.** Multipanel gill-net in “dry” arm of “Bucket Spring”, HL 98-38.



**Fig. 6.** North end of Alligator Hole, looking south; HL 98-39.

**HL 98-39**

Keep River drainage, Alligator Hole, a long deep steep-banked isolated billabong of the Keep River, rocky and muddy at north end (Fig. 6), sandy with mud at south end, about 25 m wide. 15° 41' 20" S 129° 02' 13" E. Water somewhat turbid olive colour, 30.6°C, 0 ppt, 82.2 µs, pH 6.8, 2.7 m deep in centre, no current. Substrate sand, mud, rocks, leaf litter and logs. Aquatic vegetation of *Nymphaea* sp. (*N. macrosperma* or *N. violacea*), *Nymphoides* sp. (probably *N. indica*, none flowering), and *Urtricularia australis*. Shore steep sandy banks, with varied riparian vegetation, open woodland behind. 6 October 1998. 1400-1615 and 1830-2100 hrs. Coll. H. Larson and P. Horner, using two multipanel gill-nets.

**HL 98-40**

Keep River drainage, Milligan Lagoon (Fig. 7), a large open curved isolated billabong of the Keep River, in blacksoil plains. 15° 37' 17" S 129° 00' 20" E. Water somewhat turbid yellow-grey colour, 31.1°C, 0 ppt, 82.1 µs, pH 7.2, about 1.5 m deep, no current. Substrate thick deep mud, leaf litter. Aquatic vegetation of *Nymphaea* (*N. macrosperma* or *N. violacea*), *Hydrilla verticillata* and *Chara* sp., forming dense mats. Bright green spiky sponge on vegetation (Spongillidae, probably *Radiospongilla* sp.). Shore open sloping blacksoil banks, with short grasses, *Barringtonia acutangula* and *Lysiphyllum cunninghamii*, open woodland behind. 7 October 1998. 1130-1230 hrs. Coll. H. Larson, by scoop-net.



**Fig. 7.** Milligan Lagoon, north end, HL 98-40.

**HL 98-41**

Sandy Creek, Augustus Hole, a large waterhole in main creek bed (Fig. 8). 15° 31' 31" S 129° 19' 11" E. Water clear, 32.7°C, 0.1 ppt, 311.9 µs, pH 7.6, 1.5 m deep, no current. Substrate coarse sand, leaf litter. Aquatic vegetation absent. Shore on east bank a rocky gorge, on west bank steep sandy banks, with riparian vegetation mostly of *Pandanus spiralis*, *Melaleuca*, *Barringtonia acutangula* and *Nauclea orientalis*, open woodland behind. 7 October 1998. 1700-1900 and 2030-2130 hrs. Coll. H. Larson and P. Horner, by scoop-net and hook and line.



Fig. 8. Sandy beach near south end of Augustus Hole, HL 98-41.

#### HL 98-42

Sandy Creek, Augustus Hole, at south end of main waterhole where it meets small spring-fed creek flowing over small boulders (Fig. 9), among grassy banks.  $15^{\circ} 31' 42''$  S  $129^{\circ} 19' 30''$  E. Water clear,  $30.8^{\circ}\text{C}$ , 0.2 ppt,  $312.2\ \mu\text{s}$ , pH 7.6, 0.5-1.5 m deep, current slow to moderate. Substrate rocks, sand, small boulders, *Melaleuca* leaf litter. Some green ?*Radiospongilla* sp. and algae present on rocks. Aquatic vegetation practically absent, some small *Eleocharis* sp. and grasses. Shore open, almost no banks, with grasses, few *Pandanus spiralis* and *Melaleuca* sp., open woodland behind. 8 October 1998. 0930-1030 hrs. Coll. H. Larson, by scoop-net.



Fig. 9. South end Augustus Hole, HL 98-42.

#### HL 98-43

Sandy Creek, Augustus Hole, at north end of main waterhole (Fig. 10), forming series of small open sandy and rocky pools joined by narrow stream.  $15^{\circ} 31' 00''$  S  $129^{\circ} 18' 46''$

E. Water clear, 30.9°C, 0.2 ppt, 333.2  $\mu$ s, pH 7.6, 0.5 m deep, current slow to moderate. Substrate white sand, rocks, leaf litter. Aquatic vegetation practically absent, some small *Eleocharis* sp. Shore low grassy banks, with grasses, overhanging *Pandanus spiralis* and *Melaleuca* sp., open woodland behind. 8 October 1998. 1115-1145 hrs. Coll. H. Larson, by scoop-net.



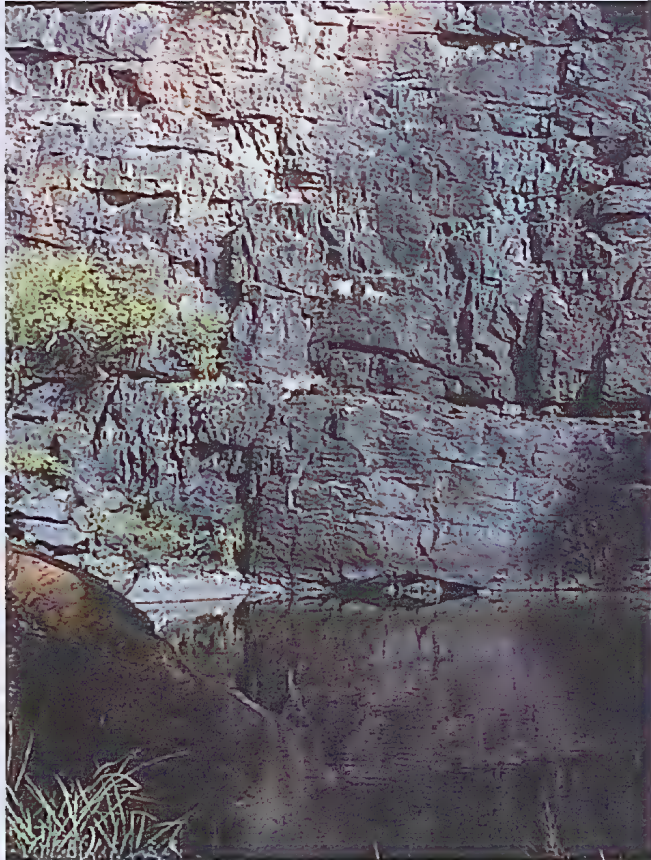
Fig. 10. Open rocky pool, north end Augustus Hole, HL 98-43.

#### HL 98-44

Sandy Creek, Augustus Hole, just north of sandy beach by campsite near south end of waterhole. 15° 31' 31" S 129° 19' 11" E. Water clear, 32.7°C, 0.1 ppt, 311.9  $\mu$ s, pH 7.6, 2-2.7 m deep, no current. Substrate coarse sand, leaf litter. Aquatic vegetation absent. Shore on east bank a rocky gorge, on west bank steep sandy banks, with riparian vegetation mostly of *Pandanus spiralis*, *Melaleuca*, *Barringtonia acutangula* and *Nauclea orientalis*, open woodland behind. 8 October 1998. 1230-1340 hrs. Coll. H. Larson and P. Horner, two multipanel gill-nets.

#### HL 98-45

Sandy Creek drainage, Emerald Spring (Fig. 11), large spring-fed (?) pool at base of vertical sandstone cliff. 15° 31' 59" S 129° 15' 55" E. Water greenish, relatively clear, 32°C, 0 ppt, 20.8  $\mu$ s, pH 6.4, about 2.5 m deep, no current. Substrate sand, rock, leaf litter. Aquatic vegetation green algae on rocks and plant rootlets. Shore half sandstone cliff, half sloping sandy banks bound by rootlets, few *Melaleuca*, with open woodland behind. 8 October 1998. 1600-1700 and 2045-2130 hrs. Coll. H. Larson, by scoop-net.



**Fig. 11.** Cliff and pool, Emerald Spring, HL 98-45.



**Fig. 12.** Oakes Creek by junction with Keep River, HL 98-46.

**HL 98-46**

Keep River system, Oakes Creek, at junction with Keep River (Fig. 12), creek broken into series of shallow pools. 15° 19' 19" S 129° 05' 21" E. Water turbid, 35.1°C, 48.8 ppt, 0.5 m deep, no current. Substrate sand, rock, mud layer mixed with sand. Aquatic vegetation absent, green algal bloom in some pools. Last pool in which fish were found, about 0.5 km up creek from junction, was 40.5°C, 42.5 ppt. Shore low sandy banks of low grasses and small bushy *Melaleuca* sp., low open savannah woodland behind. 9 October 1998. 1430-1515 hrs. Coll. H. Larson, by scoop-net.

**HL 98-47**

Keep River, in river directly opposite junction with Oakes Creek (Fig. 13). 15° 19' 21" S 129° 05' 24" E. Water somewhat turbid, 33.3°C, 47 ppt, 2 m deep, current slow. Almost no tidal movement. Substrate mud, sandy mud, rock, logs. Aquatic vegetation absent. Shore low muddy banks with scattered low grasses, *Sesuvium portulacastrum*, *Aegiceras corniculatum*, *Avicennia marina*, small bushy *Melaleuca* sp., low open savannah woodland behind. 9 October 1998. 1730-1900 and 2000-2200 hrs. Coll. H. Larson and P. Horner, by two multipanel gill-nets.



**Fig. 13.** Keep River, by junction with Oakes Creek, HL 98-47.

**HL 98-48**

Sandy Creek, billabongs in broad rounded sandy un-named creek bed (Fig. 14) broken into series of pools 0.25-1 km long. 15° 23' 38" S 129° 11' 10" E. Water clear greenish, 32.8°C, 0.1 ppt, 99.5 µs, pH 7.2, 1.5 m deep, no current. Substrate sand, leaf litter, thick vegetation, logs and sticks. Aquatic vegetation *Chara* sp., *Urticularia australis*, *Najas tenuifolia*, *Nymphaea* (*N. macrosperma* or *N. violacea*); *Enteromorpha* sp. and other green algae forming blooms at ends of some pools. Shore low to steeply sloping sandy banks, grassy, with scattered *Eucalyptus* and *Melaleuca*, open woodland behind. 10 October 1998. 1530-1700-2000-2100 hrs. Coll. H. Larson and P. Horner, by 20' seine and scoop-nets.



**Fig. 14.** Sandy Creek billabong, one of several; HL 98-48.

**HL 98-49**

Sandy Creek estuary, east bank (Fig. 15). 15° 16' 05" S 129° 12' 55" E. Water muddy grey-green, 30.1°C, 40.5 ppt, 2 m deep, current slow. Tide low. Substrate mud. Aquatic vegetation absent. Shore on east bank steep mud banks, grass-topped, with wide salt flat behind, on which were scattered grasses (*Sporobolus virginicus*), *Sesuvium portulacastrum* and small bushy *Melaleuca* sp. 11 October 1998. 1110 hrs. Sight record only, H. Larson.



**Fig. 15.** Sandy Creek estuary, looking upstream, HL 98-49.

**HL 98-50**

Sandy Creek estuary, isolated pool in small creeklet entering estuary on east bank (Fig. 16), just inland from HL 98-49. 15° 16' 05" S 129° 12' 55" E. Water turbid, muddy, 34.6°C, 45.3 ppt, 0.5 m deep, no current. Substrate mud. Aquatic vegetation absent. Shore salt flat, with *Sesuvium portulacastrum*. 11 October 1998. 1115-1145 hrs. Coll. H. Larson, by scoop-net.



**Fig. 16.** Salt flats, Sandy Creek estuary, just east of HL 98-50.

**HL 98-51**

Sandy Creek tributary, isolated pool in narrow eroded channel (Fig. 17), one of several, rest of channel dry. 15° 19' 11" S 129° 13' 51" E. Water rather turbid greenish, 39°C, 61.1 ppt, 0.5-1 m deep, no current. Substrate clay, mud, logs, many fallen trees. Aquatic vegetation absent. Shore steep clay-mud banks full of tree roots, with low open woodland behind, mostly *Melaleuca*. 11 October 1998. 1245-1300 hrs. Coll. H. Larson, by scoop-net.



**Fig. 17.** Tributary channel of Sandy Creek, HL 98-51.

**HL 98-52**

Keep River, on south side of bridge where Legune Station road crosses river (Fig. 18), river broken into series of large pools. 15° 24' 23" S 129° 03' 45" E. Water somewhat turbid, greenish, 32.5°C, 0.1 ppt, 163.1  $\mu$ s, pH 7.2, at least 1 m deep, no current. Substrate rock slabs, rocks, gravel, sand, logs and leaf litter. Aquatic vegetation absent. Shore steep blacksoil banks with *Pandanus ?aquaticus*, *Barringtonia acutangula* and *Melaleuca* sp., open woodland behind. 11 October 1998. 1415-1515 hrs. Coll. H. Larson and P. Horner, by scoop-net and hook and line.



**Fig. 18.** Keep River, just west of Legune Station road crossing, HL 98-52.

## FISH SPECIES

The species listed here are based on the survey collections and sight records or literature records. Station numbers are given at which each species was collected, followed by number of specimens collected and their size range (in standard length) in parentheses. All specimens retained are registered in the NTM reference collection.

### PRISTIDAE - SAWFISH

#### ***Pristis clavata* Garman, 1906 – Dwarf Sawfish**

*Pristis clavata* Garman, 1906: 208 (Queensland, Australia).

HL 98-47, 1(840).

This small species is definitely known only from northern Australia so far, from Cairns to the Kimberley coast. It is usually found in estuaries or close to the coast.

#### ***Pristis microdon* Latham, 1794 – Freshwater Sawfish**

*Pristis microdon* Latham, 1794: 280 (no locality). - Midgley 1981: 56 (Police Hole).

No material was retained from Midgley's collection, but his identification is accepted here, given that this isolated site is well up into freshwater (the preferred habitat of this species). It is possible that Midgley's specimen was also *P. clavata*, as the two species have been confused in the past (P. Last, pers. comm.). *Pristis microdon* is known from the Victoria, Daly and Adelaide Rivers (and elsewhere in northern Australia and South-east Asia) and appears to be confined mostly to fresh water (Last and Stevens 1994).

#### MEGALOPIDAE - TARPONS

##### ***Megalops cyprinoides* (Broussonet, 1782) – Ox-eye Herring**

*Clupea cyprinoides* Broussonet, 1782: 39 (Tanna, New Hebrides)

HL 98-36, 1(388); HL 98-38, 1(discarded); HL 98-39, 3(189-201); HL 98-45, sight record only; HL 98-48, sight record only.

#### CLUPEIDAE - HERRINGS

##### ***Nematalosa erebi* (Günther, 1868) – Bony Bream**

*Chatoessus erebi* Günther, 1868: 407 (Mary River, Queensland).

*Nematalosa erebi* - Midgley 1981: 56 (Police Hole).

HL 98-39, 10(77-172); HL 98-42, sight record only; HL 98-44, released; HL 98-47, 1(207). Also specimens in NTM collection from Policeman Waterhole and Cockatoo Lagoon.

#### ENGRAULIDIDAE - ANCHOVIES

##### ***Thryssa brevicauda* Roberts, 1978 – Short-tail Thryssa**

*Thryssa brevicauda* Roberts 1978: 29 (mangrove creek, Lower Fly River, PNG).

HL 98-47, 4(90-101).

#### ARIIDAE - FORK-TAILED CATFISH

##### ***Arius graeffei* Kner and Steindachner, 1866 – Blue Catfish**

*Arius graeffei* Kner and Steindachner, 1866: 383 (Samoa, locality doubtful).

HL 98-39, 11(155-173); HL 98-44, 1(243); HL 98-47, 3(180-310). Also specimens in NTM collection from Policeman Waterhole.

##### ***Arius leptaspis* (Bleeker, 1862) – Salmon Catfish**

*Hexanematicthys leptaspis* Bleeker, 1862: 27 (New Guinea).

NTM S.11405-008, from Policeman Waterhole. The "ariid sp." reported by Midgley (1981) from "Police Hole" could be this species or *Arius graeffei* (specimens not retained).

##### ***Arius midgleyi* Kailola and Pierce, 1866 – Midgley's Catfish**

*Arius midgleyi* Kailola and Pierce, 1988: 75-87 (Wickham Gorge, Victoria River, Northern Territory).

HL 98-44, large specimen, released.

**PLOTOSIDAE - EEL-TAILED CATFISH**

***Anodontiglanis dahli* Rendahl, 1922 – Toothless Catfish**

*Anodontiglanis dahli* Rendahl, 1922: 169 (Glencoe River, Glencoe, NT).

HL 98-44, 1(318-320), larger specimen skeletonised.

***Neosilurus ater* (Perugia, 1894) – Black Catfish**

*Lambertia atra* Perugia, 1894: 551 (Inawi, New Guinea).

Specimens in NTM collection from Policeman Waterhole.

***Neosilurus hyrtlui* (Steindachner, 1867) – Hyrtl's Catfish**

*Neosilurus hyrtlui* Steindachner, 1867: 14 (Fitzroy River, Rockhampton).

HL 98-35, sight record only; HL 98-45, 3(105-120).

***Porochilus rendahli* (Whitley, 1928) – Rendahl's Catfish**

*Copidoglanis rendahli* Whitley, 1928: 214 (substitute name for *Copidoglanis obscurus* Rendahl, preoccupied).

HL 98-37, possible sight record only. Specimens in NTM collection from Policeman Waterhole.

**BELONIDAE - LONGTOMS**

***Strongylura krefftii* (Günther, 1866) – Freshwater Longtom**

*Belone krefftii* Günther, 1866: 250 (Australia).

HL 98-44, 2(347-560), larger skeletonised.

**MELANOTAENIIDAE - RAINBOWFISH**

***Melanotaenia nigrans* (Richardson, 1843) – Black-banded Rainbowfish**

*Atherina nigrans* Richardson, 1843: 180 (King River, Port Essington, NT).

HL 98-45, 17(13-75).

***Melanotaenia splendida australis* (Castelnau, 1875) – Red-tailed Rainbowfish**

*Neoatherina australis* Castelnau, 1875: 32 (Swan River Colony, WA).

*Melanotaenia* sp. - Midgley 1981: 56 (Police Hole).

HL 98-35, 10(13-47); HL 98-36, sight record only; HL 98-37, 18(15-55); HL 98-39, 23(15-33); HL 98-41, 33(9-30); HL 98-42, 9(8-40); HL 98-43, 2(29-30); HL 98-45, 23(18-70); HL 98-48, 35(11-50); HL 98-52, 28(7-19). Specimens in NTM collection from Cockatoo Lagoon and West Gorge, Keep River.

**ATHERINIDAE - HARDYHEADS**

***Craterocephalus stercusmuscarum* (Günther, 1867) – Fly-specked Hardyhead**

*Atherina stercusmuscarum* Günther, 1867: 64 (Cape York).

HL 98-35, 2(17-18); HL 98-36, sight record only; HL 98-39, 14(22-53); HL 98-40, 35(11-30); HL 98-41, 30(12-47); HL 98-42, 1(22); HL 98-43, 5(14-20).

#### AMBASSIDAE - GLASS-PERCHLETS

##### ***Ambassis mulleri* Klunzinger, 1879 – Muller's Glassfish**

*Ambassis mulleri* Klunzinger, 1879: 346 (Port Darwin).

HL 98-37, 4(33-35); HL 98-39, 2(21-23); HL 98-41, 2(12-21); HL 98-45, 1(31); HL 98-48, 77(27-42). Also specimens in NTM collection from the Keep River and Cockatoo Lagoon.

##### ***Parambassis gulliveri* (Castelnau, 1878) – Giant Glassfish**

*Acanthopercra gulliveri* Castelnau, 1878: 45 (Norman River, Gulf of Carpentaria).

HL 98-39, 4(103-120). Specimens in NTM collection from a Keep River billabong.

#### CENTROPOMIDAE - BARRAMUNDI

##### ***Lates calcarifer* (Bloch, 1790) - Barramundi**

*Holocentrus calcarifer* Bloch, 1790: 100 (Japan).

*Lates calcarifer* - Midgley 1981: 56 (Police Hole).

HL 98-41, 1(270); HL 98-42, sight record only; HL 98-44, sight record only; HL 98-48, released; HL 98-52, sight record only.

#### TERAPONTIDAE - GRUNTERS

##### ***Amniataba percoides* (Günther, 1864) – Banded Grunter**

*Therapon percoides* Günther, 1864: 374 (Fitzroy River, near Rockhampton).

*Amniataba percoides* - Midgley 1981: 56 (Police Hole).

HL 98-41, 18(8-23); HL 98-42, 2(11-11). Specimens in NTM collection from Policeman Waterhole.

##### ***Hephaestus jenkinsi* (Whitley, 1945) – Jenkins' Grunter**

*Mesopristes jenkinsi* Whitley, 1945: 26 (Ivanhoe Station, Ord River, WA).

HL 98-41, 1(255).

##### ***Leiopotherapon unicolor* (Günther, 1859) – Spangled Grunter**

*Therapon unicolor* Günther, 1859: 277 (Gwydir River and Darling Downs, NSW).

*Leiopotherapon unicolor* - Midgley 1981: 56 (Police Hole).

HL 98-35, sight record only; HL 98-36, sight record only; HL 98-37, 1(67); HL 98-42, sight record only; HL 98-45, sight record only. Specimens in NTM collection from Policeman Waterhole, Cockatoo Lagoon and West Gorge, Keep River.

##### ***Terapon jarbua* (Forsskal, 1775) - Targetfish**

*Sciaena jarbua* Forsskal, 1775: 12 (Djeddah, Red Sea.).

HL 98-46, 8(9-13); HL 98-50, 13(11-22); HL 98-51, 3(15-19).

**APOGONIDAE - CARDINALFISH**

***Glossamia aprion* (Richardson, 1842) – Mouth Almighty**

*Apogon aprion* Richardson, 1842: 16 (King River, Victoria, Port Essington, NT).

HL 98-37, 1(67); HL 98-39, 1(48); HL 98-40, 13(11-21); HL 98-41, 5(21-32); HL 98-42, 1(62); HL 98-45, 6(10-132); HL 98-48, 6(20-51).

**TOXOTIDAE - ARCHERFISH**

***Toxotes chatareus* (Hamilton Buchanan, 1822) – Spotted Archerfish**

*Coilus chatareus* Hamilton Buchanan, 1822: 101, 370 (mouthes of the Ganges).

*Toxotes chatareus* - Midgley 1981: 56 (Police Hole).

HL 98-39, 2(122-125); HL 98-41, 1(177); HL 98-47, sight record only; HL 98-52, sight record only. Specimens in NTM collection from Policeman Waterhole.

**MUGILIDAE - MULLET**

***Liza cf alata* (Steindachner, 1892) – Diamond Mullet**

*Mugil alata* Steindachner, 1892: 133 (Madagascar).

HL 98-50, 44(6-45).

These juvenile specimens appear to belong to this species, however, juvenile mugilids are notoriously difficult to identify.

***Liza tade* (Forsskal, 1775) – Flathead Mullet**

*Mugil crenilabis* var. *tade* Forsskal, 1775: 74 (Red Sea).

HL 98-98-47, 6(180-320).

This species usually has bright orange to red markings on the eye; however, these specimens varied from orange to bright green. Only one specimen had orange-red eye markings and bright yellow on the fins (resembling specimens taken from mangrove creeks on Field Island, Kakadu National Park).

***Rhinomugil nasutus* (De Vis, 1883) – Pop-eye Mullet**

*Mugil nasutus* De Vis, 1883: 621 (Cardwell, Qld).

HL 98-50, 1(39).

**POLYNEMIDAE - THREADFINS**

***Eleutheronema tetradactylum* (Shaw, 1804) – Four-finger Threadfin**

*Polynemus tetradactylus* Shaw, 1804: 155 (India).

HL 98-47, 1(255)

## ELEOTRIDIDAE - GUDGEONS

### *Mogurnda mogurnda* (Richardson, 1844) – Purple-spotted Gudgeon

*Eleotris mogurnda* Richardson, 1844: 4 (Port Essington).

HL 98-35, sight record only; HL 98-37, 16(13-76). Specimens in NTM collection from Keep River and Cockatoo Lagoon.

### *Oxyeleotris selheimi* (Macleay, 1884) – Black-banded Gudgeon

*Eleotris selheimi* Macleay, 1884: 33 (replacement name for *Eleotris planiceps* Macleay, 1882).

HL 98-39, 13(10-56); HL 98-40, 13(11-21); HL 98-48, 14(31-62). Specimens in NTM collection from Cockatoo Lagoon.

## GOBIIDAE, GOBIINAE - GOBIES

### *Amoya* sp. – Amoy Goby

HL 98-50, 32(7-10).

This is a previously known undescribed species

### *Glossogobius aureus* (Akihito and Meguro, 1975) – Golden Goby

*Glossogobius aureus* Akihito and Meguro, 1975: 128 (Sumiyoshi, Iriomotejima, Okinawa Prefecture, Japan).

*Glossogobius* sp. - Midgley 1981: 56 (Police Hole).

HL 98-41, 17(17-50); HL 98-48, 14(14-76). Specimens in NTM collection from Policeman Waterhole.

## GOBIIDAE, OXUDERCINAE - MUDSKIPPERS

### *Oxuderces wirzi* (Koumans, 1938) – Peacock Mudskipper

*Apocryptodon wirzi* Koumans, 1938: 26 (Papua New Guinea).

HL 98-50, 5(15-25).

### *Periophthalmus argentilineatus* Valenciennes, 1837 – Silver-lined Mudskipper

*Periophthalmus argentilineatus* Valenciennes, 1837: 191 (Irian Jaya and Moluccas).

HL 98-47, sight record only; HL 98-49, sight record, probably of this species.

## CRUSTACEA

### DECAPODA, PALAEMONIDAE

### *Macrobrachium rosenbergii* (de Man, 1879)

HL 98-52. *Macrobrachium rosenbergii* is a “Large, euryhaline, catadromous species ...”, found from the Fitzroy River in Western Australia across the Top End to the Normanby

River in Queensland (Short, in prep.). Long-armed prawns (or cherabin) are sought after as food.

***Macrobrachium bullatum* Fincham, 1989**

HL 98-35. This is a small, oligohaline species restricted to north-western Australia, from the Lennard River in Western Australia to Rosie River, Northern Territory (Short, in prep.).

**DECAPODA, ATYIDAE**

***Caridinides wilkinsi* Calman, 1926.**

HL 98-35. This is a poorly known species, found in freshwaters of the Northern Territory and Queensland (Smith and Williams 1982). Coombes (1996) stated that the species is common in Top End freshwaters (from the Finniss system across to the Goyder), based on MAGNT records.

**DECAPODA, OCYPODIDAE**

***Uca* sp.**

HL 98-50. One specimen was collected, but was lost before identification could be made. There are 14 species of fiddler crabs known from the Northern Territory (George and Jones 1982).

**MOLLUSCA**

**GASTROPODA, PROSOBRANCHIA, VIVIPARIDAE**

***Notopala essingtonensis* (Frauenfeld, 1862)**

HL 98-39; HL 98-40; HL 98-48.

Distribution: north coastal, Gulf of Carpentaria.

**GASTROPODA, PULMONATA, LYMNÆIDAE**

***Austropeplea lessoni* (Deshayes, 1830)**

HL 98-35; HL 98-37; HL 98-39; HL 98-40; HL 98-43.

Distribution: Coastal SE and NE Australia, Gulf of Carpentaria, W Plateau, southern gulfs, Murray-Darling basin, Bulloo River basin, Lake Eyre basin.

**GASTROPODA, PULMONATA, PLANORBIDAE**

***Amerianna carinata* (H. Adams, 1861)**

HL 98-40; HL 98-41.

Distribution: throughout coastal northern Australia; also introduced into Java, Thailand, Nigeria and Martinique.

***Gyraulus cf essingtonensis* (E.A. Smith, 1882)**

HL 98-48.

Distribution unknown, due to taxonomic uncertainty.

#### BIVALVIA, PALAEOHETERODONTA, HYRIIDAE

##### *Velesunio angasi* (Sowerby, 1867)

HL 98-37; HL 98-40.

Distribution: Coastal Gulf of Carpentaria to Daly River catchment, Fitzroy River catchment, WA. Keep River specimens therefore represent a new locality record.

## DISCUSSION

Over the seven-day survey period, 17 sampling stations were made, recording 32 freshwater and estuarine fish species (and 11 frogs, 13 reptiles, 93 birds, 5 mammals) from the Keep River and Sandy Creek region. Adding in the few additional species from the literature and museum collections, gives a total of 35 species of fishes known so far from the area. Of these 35, several are noteworthy.

### Fishes - threatened species

The two species of sawfish found in the Keep River, the Dwarf Sawfish *Pristis clavata* and the Freshwater Sawfish *Pristis microdon*, are of national and international significance. These large elasmobranchs are poorly understood in Australia, and very little is known of their distribution and ecology.

Freshwater Sawfish, which grow to at least 2 metres in length, are “highly vulnerable” in waterbodies where barramundi gill net fishing is carried out, and may be threatened in areas where gill net poaching occurs (Last and Stevens 1994). The Freshwater Sawfish is listed as “Endangered” in the IUCN’s Red List, and as “Potentially Threatened” in the 1998 Australian Society for Fish Biology’s (ASFB) Threatened Fish List (ASFB’s Threatened Fish Committee is in the process of adopting IUCN methodology for determining the conservation status of fish species). In Australia, the Freshwater Sawfish is found in freshwater and upper reaches of estuaries, and may be isolated in small billabongs for several years, awaiting floods. This species is known from several rivers in northern W.A., the N.T. and Cape York, Qld, but its true distribution is not known. The species is known from the Keep River only from Midgley’s (1981) field report (no specimen retained).

The Dwarf Sawfish is usually coastal in distribution, but can travel long distances up rivers into freshwater. Mature males are not known from museum collections (the specimen obtained is a young male, awaiting further study). Its conservation status is not known (through lack of data), and it may only occur in northern Australia. The single specimen obtained during the survey was living in 47 ppt salinity, in the upper reaches of the Keep estuary.

Although both these species of sawfish do occur in other drainage systems in northern Australia, it should be borne in mind that the fish fauna of the Keep River system is practically pristine, with a very low level of fishing effort by commercial fishers due to its remoteness (e.g. no effort in the area in 1996 or 1997, Roland Griffin, DPIF, pers. comm.)

and probably with a similarly low recreational fishing pressure. Other river systems have or may have had greater fishery pressure and therefore a potential impact on sawfish populations (and poaching is an unknown factor). Therefore the sawfish populations (and those of other fish species) may be intact in the Keep.

### **Fishes - freshwater species**

The Black-lined Rainbowfish *Melanotaenia nigrans* was found only at one locality, Emerald Spring. This species occurs in many habitat types and has a wide but patchy distribution (Larson and Martin 1990). It is often most abundant in rocky or escarpment habitat and is usually found about 40 km from the coast (as is Emerald Spring).

The other freshwater fish species were those normally to be expected in the available habitats surveyed. The number of species recorded (25) is probably not complete. Hutchins (1981) and Allen (1982) recorded freshwater fishes from the Ord River or Lake Argyle, including several species expected from the Keep but not yet collected (such as Reticulated Glassfish *Ambassis macleayi*, Nurseryfish *Kurtus gulliveri*, Strawman *Craterocephalus stramineus*, and Butler's Grunter *Syncomistes butleri*). It is very likely that these species occur in the Keep and Sandy area, as they are also present in rivers to the east and west of these systems.

In the Northern Territory, the nearest river east of the Keep which has been surveyed more than once is the Wickham River, in the Victoria River drainage system. Thirty-five species are now known from the Wickham, of which 22 are shared with the Keep (Larson in prep.). In a six-day survey of the upper Wickham River, 20 of the 35 species were obtained with the same techniques used for the present survey.

In comparison, although about 44 "freshwater" species are known from the Alligator Rivers Region, only 25 of these were taken during sampling of the Nourlangie and Magela Creeks during a nine-day survey using the same techniques used for the present survey (Larson 1995). Twenty-five of the 35 species collected from the Keep and Sandy are generally considered to be "freshwater fishes" *sensu* Larson and Martin (1990). The basic species assemblages found in the Sandy and Keep systems are similar to those of the Alligator Rivers region but for groups which do not occur in the Victoria River system or westward of it, such as the Osteoglossidae (saratoga) and the freshwater species of the family Pseudomugilidae (blue-eyes).

There are no feral (introduced) fishes in these rivers. One possible invading species may be *Gambusia affinis*, the Mosquitofish, which has invaded many Western Australian river systems and is known from streams north of Broome and may be colonising other streams (MAGNT records; Arthington and Lloyd 1989). The Mosquitofish was introduced in Darwin and some rivers between Darwin and the Fitzmaurice River in the 1940s, but the only known population remaining in the NT is in Railway Dam in the city of Darwin (Graham White, DPIF, pers. comm.).

### **Fishes - estuarine species**

Ten of the 35 species recorded are estuarine species (e.g. Dwarf Sawfish *Pristis clavata*, Pop-eye Mullet *Rhinomugil nasutus*, Silver-lined Mudskipper *Periophthalmus argentilineatus*). By way of contrast, 181 fish species are known from the estuaries and coasts within Kakadu National Park (Larson 1997) and 107 from the Roper River estuary

and nearby creeks (Larson 1996). The Keep River and Sandy Creek estuaries would be expected to have 100 or more species of estuarine fishes. The estuarine species recorded were obtained at two sites only (HL 98-47 on the Keep River and HL 98-50 on Sandy Creek). From the appearance of the habitat (rocky bars and muddy shoals with mangrove-lined banks) and considerable fish activity observed toward dusk and at night, there were many more species present than were recorded. To sample the estuarine habitats adequately, additional techniques are required (2 m beam trawl, rotenone) in addition to gill and scoop nets, using a larger vessel than the 10' aluminium dinghy used for this survey.

From observations made during the survey, it is expected that the estuarine fish fauna of the Keep and Sandy would likely be similar to that of the Roper River estuary and probably the Alligator Rivers estuaries. Additionally, Wells (1995) shows similarities, by presence/absence of mangrove species, between the rivers entering the Joseph Bonaparte Gulf (e.g. the Keep and Victoria) and those Northern Territory rivers entering the Gulf of Carpentaria (e.g. the Roper). These are all seasonally arid areas, with low mangrove diversity (Wells 1995). It has not yet been demonstrated if there is any link between low mangrove diversity and low diversity of fishes associated with the mangroves. There is a relationship between mangrove productivity (based on invertebrate diversity) and latitude (rainfall) indicated by Hanley and Banks (1995).

It is likely that the most speciose fish families in the Keep and Sandy estuaries will be the Gobiidae (gobies, gudgeons and mudskippers), Ariidae (fork-tailed catfish), Engraulidae (anchovies), Sciaenidae (jewfish), Mugilidae (mullet), Cynoglossidae (tongue soles), and the Clupeidae (sardines and herrings), although not necessarily in that order. However, the Gobiidae can be easily predicted to be the most speciose family, as it has been shown to be so in a number of coastal and estuarine habitats in the N.T. (Larson 1997; Larson and Williams 1997). The Gobiidae is also the most speciose marine fish family in the world (Nelson 1976).

### **Other vertebrates**

Terrestrial vertebrates were observed or sampled on an *ad hoc* basis. Aquatic vertebrates other than fish were not sought (i.e. no traps deployed), so no turtles or watersnakes were recorded. Freshwater Crocodiles *Crocodylus johnstoni* were attracted to the gill nets and several became entangled (and were released unharmed). Midgley (1981) recorded a single Estuarine Crocodile, *Crocodylus porosus*, at Policeman Waterhole in Keep River National Park.

One species of note is the recently described scincid lizard *Ctenotus rimicola*, which has a subspecies (*Ctenotus rimicola camptris*) restricted to the black soil plains around the Keep River (Horner and Fisher 1998). Horner and Fisher rate the species' conservation status as "Rare or insufficiently known".

### **Aquatic invertebrates**

The aquatic invertebrates comprised species assemblages usually associated with Northern Territory rivers, creeks and billabongs. Insects and molluscs were common in most waterbodies, and some insects locally abundant. The freshwater mussel *Velesunio angasi*, apparently abundant in the area, forms a new locality record for the species. Crustacea

other than two species of *Macrobrachium* were not abundant. However, the abundance of atyid shrimps can be sporadic (Coombes 1996), so the more speciose atyid genus *Caridina* may be present in the region.

## CONCLUSIONS

Much work has been done on terrestrial systems and groundwater hydrology but very little done on the biological systems that actually live **in** water. The Ord River Stage 2 development has the potential to impact the Keep River system and its associated aquatic biota considerably, adding water and its associated organisms from the Ord River system. The project, still under development, may include:

- the potential for irrigation water to enter the Keep, causing the river to flow continuously;
- hillside drains from Knox Creek Plain to enter the Keep River;
- a regulating storage dam of 3.5 gigaliters is proposed for the Keep River Plain;
- stormwater drains to enter the Keep River, via natural drainage systems, at several locations;
- flood protection levees, with their banks above the present surface, are presently proposed along the Keep River and Sandy Creek, with parts of the Keep possibly having levees built on both sides of the river;
- a bridge may be constructed across the Keep in the vicinity of the existing Legune Station road;
- approximately 540 km of channels, drains and levees within the project area.

### Adequacy of data

The short late dry season survey is inadequate in that it does not give a complete picture of the aquatic fauna (freshwater and estuarine). It does provide a good insight as to the fauna which might be present in the Keep and Sandy freshwater drainages, with possibly another 10 fish species not yet recorded.

The estuarine fauna in particular (fauna restricted to downstream of all impacts) must be surveyed, as this information is almost completely lacking. The estuaries of the Keep River and Sandy Creek are extensive and probably complex. They may support between 100-200 species of fish, some of which will be of commercial and recreational importance (e.g. barramundi, jewfish, threadfin, snapper). The benthic estuarine invertebrates should be surveyed, as information is totally lacking.

An estuarine faunal survey needs to be undertaken. The Keep estuary is downstream of all the potential changes (in flow, chemistry etc.) and should therefore be monitored. However, given the dynamic nature of estuaries in the Northern Territory (e.g. at least 8 m tidal range, sediments mobilised during wet season flows), it may not be easy to distinguish between natural and man-made changes, unless good baseline data is acquired before construction and monitoring is carried out.

Further work on the aquatic fauna should continue, and monitoring sites at a number of localities, including a range of control sites, should be established as soon as possible, so that “before” data can be collected. Species assemblages of residential fish and benthic invertebrates could be monitored concurrently with hydrological and chemical monitoring.

### Conservation areas

In the following discussion, it must be borne in mind that only five main areas on each drainage system (Keep and Sandy) were sampled, and that potentially significant areas were not visited due to time constraints.

At present, Spirit Hill Station is owned by the NT Land Corporation and managed by the Parks and Wildlife Commission of the Northern Territory (PWCNT), and all or portions of the station may be incorporated into Keep River National Park in the future. The Keep River National Park provides protection for most of the upper catchment of the Keep River. However, two significant refuge areas, Alligator Hole and Milligan Lagoon, are north of the present park boundary. These two areas are different (see descriptions and illustrations above) and are considerable waterbodies which probably rarely dry up if ever (are about 2-3 m deep in the dry season), forming important refuges for aquatic fauna and some terrestrial fauna (such as waterbirds). Alligator Hole and Milligan Lagoon should be protected from changes; i.e. no drains, levees, or channels etc should be constructed upstream of or enter them. These two localities and their associated drainage systems (seasonal creeks and surrounding topography) would make good control sites for monitoring and comparative purposes. They would also make good inclusions within Keep River National Park.

Sandy Creek, although smaller than the Keep River, has several significant localities. Emerald Spring, and other spring-fed sites on the escarpment outcroppings around the Banana Hill area, are of conservation significance in that they are refuge areas for aquatic fauna and some terrestrial fauna such as the Splendid Tree-frog (*Litoria splendida*). These outcroppings (to east, west and south of Banana Hill) could form a conservation/protected area. Further work would be required to establish if any of these areas could withstand increased visitation pressure.

One area of Sandy Creek which is already visited is Augustus Hole, a long 2.7 m deep permanent section of the creek. Man-made rubbish and campsites were observed. This spectacular waterhole will certainly attract more visitors as the development proceeds and will need to be managed as soon as practicable. For example, a “catch-and-release” fishing requirement would ensure that there will always be sooty grunTERS to take a lure.

The development of Ord River Stage 2 will increase recreational fishing and visitation, which should be considered while planning monitoring programmes. It is unknown what the effect may be of the increased river flow on the endangered sawfish or any of the aquatic fauna. The entire project is basically an experiment on a whole river system, which must be carefully monitored and managed to remove the likelihood of negative impacts.

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## APPENDIX I. BIRD SPECIES RECORDED IN KEEP RIVER / SANDY CREEK AREA, OCTOBER 1998

1 = "Bucket Springs", 4-5 Oct.; 2 = Alligator Waterhole, 6 Oct.; 3 = Milligan Lagoon, 7 Oct.; 4 = Augustus Hole, 7-8 Oct.; 5 = Emerald Spring, 8 Oct.; 6 = Keep River / Oakes Creek junction, 9-10 Oct.; 7 = Keep River (old airstrip /swamp), 10 Oct.; 8 = Sandy Creek (billabong), 10 Oct.; 9 = Sandy Creek estuary, 11 Oct.; 10 = Sandy Creek tributary, 11 Oct.; 11 = Keep River at road crossing, 11 Oct.

| SPECIES<br>Common name    | Scientific name                    | SITES |   |   |   |   |   |   |   |   |    |    |
|---------------------------|------------------------------------|-------|---|---|---|---|---|---|---|---|----|----|
|                           |                                    | 1     | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| Magpie Goose              | <i>Anseranas semipalmata</i>       | .     | + | + | . | . | . | . | . | . | .  | .  |
| Pacific Black Duck        | <i>Anas superciliosa</i>           | .     | . | + | . | . | . | + | . | . | .  | .  |
| Radjah Shelduck           | <i>Tadorna radjah</i>              | .     | . | + | . | . | . | . | + | . | .  | .  |
| Australasian Grebe        | <i>Tachybaptus novaehollandiae</i> | .     | + | . | . | . | . | + | . | . | .  | .  |
| Darter                    | <i>Anhinga melanogaster</i>        | .     | . | + | + | . | + | . | . | . | .  | .  |
| Little Pied Cormorant     | <i>Phalacrocorax melanoleucos</i>  | .     | . | + | + | + | . | . | . | . | .  | .  |
| Australian Pelican        | <i>Pelecanus conspicillatus</i>    | .     | . | . | . | . | + | + | . | . | .  | .  |
| Great Egret               | <i>Ardea alba</i>                  | .     | . | . | . | . | + | . | . | . | .  | .  |
| Intermediate Egret        | <i>Ardea intermedia</i>            | .     | . | + | . | . | . | . | . | . | .  | .  |
| Nankeen Night Heron       | <i>Nycticorax caledonicus</i>      | .     | + | . | + | . | . | . | . | . | .  | .  |
| Australian White Ibis     | <i>Threskiornis molucca</i>        | .     | . | + | . | . | . | . | . | . | .  | .  |
| Straw-necked Ibis         | <i>Threskiornis spinicollis</i>    | .     | . | + | . | . | . | . | . | . | .  | .  |
| Royal Spoonbill           | <i>Platalea regia</i>              | .     | . | . | . | . | . | + | . | . | .  | .  |
| Black-necked Stork        | <i>Ephippiorhynchus asiaticus</i>  | .     | . | . | . | . | + | . | . | . | .  | .  |
| Osprey                    | <i>Pandion haliaetus</i>           | .     | . | . | + | . | . | . | . | . | .  | .  |
| Whistling Kite            | <i>Haliastur spheurnus</i>         | .     | + | . | + | . | + | . | + | + | .  | +  |
| White-bellied Sea-Eagle   | <i>Haliaeetus leucogaster</i>      | .     | . | . | + | + | + | . | + | . | .  | +  |
| Brown Goshawk             | <i>Accipiter fasciatus</i>         | .     | + | . | + | . | . | . | . | . | .  | .  |
| Collared Sparrowhawk      | <i>Accipiter cirrhocephalus</i>    | .     | . | . | . | . | . | . | + | . | .  | +  |
| Wedge-tailed Eagle        | <i>Aquila audax</i>                | .     | . | . | . | + | . | . | . | . | .  | .  |
| Brolga                    | <i>Grus rubicunda</i>              | .     | . | + | . | . | . | . | . | . | .  | .  |
| Australian Bustard        | <i>Ardeotis australis</i>          | .     | . | . | + | . | . | + | . | . | .  | .  |
| Marsh Sandpiper           | <i>Tringa stagnatilis</i>          | .     | . | . | . | . | . | + | . | . | .  | .  |
| Common Greenshank         | <i>Tringa nebularia</i>            | .     | . | + | . | . | . | . | . | . | .  | .  |
| Common Sandpiper          | <i>Actitis hypoleucos</i>          | .     | . | . | + | . | . | . | . | . | .  | .  |
| Sharp-tailed Sandpiper    | <i>Calidris acuminata</i>          | .     | . | . | . | . | . | + | . | . | .  | .  |
| Bush Stone-curlew         | <i>Burhinus grallarius</i>         | .     | . | . | + | . | + | . | . | . | .  | .  |
| Black-winged Stilt        | <i>Himantopus himantopus</i>       | .     | . | . | . | . | + | . | . | . | .  | .  |
| Red-kneed Dotterel        | <i>Erythronyx cinctus</i>          | .     | . | + | . | . | . | + | . | . | .  | .  |
| Masked Lapwing            | <i>Vanellus miles</i>              | .     | . | + | . | . | + | + | . | . | .  | .  |
| Australian Pratincole     | <i>Stiltia isabellae</i>           | .     | . | . | . | . | . | + | . | . | .  | .  |
| Silver Gull               | <i>Larus novaehollandiae</i>       | .     | . | . | . | . | . | . | . | + | .  | .  |
| Caspian Tern              | <i>Sterna caspia</i>               | .     | . | . | . | . | + | . | . | . | .  | .  |
| Common Bronzewing         | <i>Phaps chalcoptera</i>           | .     | . | . | . | . | . | . | + | . | .  | .  |
| Crested Pigeon            | <i>Ocyphaps lophotes</i>           | .     | . | + | . | . | . | + | + | . | .  | .  |
| White-quilled Rock-Pigeon | <i>Petrophassa albipennis</i>      | .     | . | . | + | . | . | . | . | . | .  | .  |
| Peaceful Dove             | <i>Geopelia striata</i>            | +     | + | + | + | . | + | + | + | . | .  | .  |
| Bar-shouldered Dove       | <i>Geopelia humeralis</i>          | +     | + | + | + | . | + | . | + | . | .  | .  |
| Red-tailed Black-Cockatoo | <i>Calyptrorhynchus banksii</i>    | .     | . | + | + | . | . | + | + | . | .  | .  |
| Galah                     | <i>Cacatua roseicapilla</i>        | +     | . | . | + | . | . | . | + | . | .  | .  |

KEEP RIVER AQUATIC FAUNA SURVEY  
APPENDIX 1 – LIST OF BIRD SPECIES

| SPECIES                     |                                   | SITES |   |   |   |   |   |   |   |   |    |    |
|-----------------------------|-----------------------------------|-------|---|---|---|---|---|---|---|---|----|----|
| Common name                 | Scientific name                   | 1     | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| Little Corella              | <i>Cacatua sanguinea</i>          | +     | + | . | . | . | . | . | + | . | .  | +  |
| Sulphur-crested Cockatoo    | <i>Cacatua galerita</i>           | .     | + | . | + | . | . | . | . | . | .  | +  |
| Cockatiel                   | <i>Nymphicus hollandicus</i>      | .     | . | . | . | . | + | + | . | . | .  | .  |
| Rainbow Lorikeet            | <i>Trichoglossus haematodus</i>   | +     | + | . | + | . | . | . | + | . | .  | .  |
| Red-winged Parrot           | <i>Aprosmictus erythropterus</i>  | +     | . | . | . | . | + | . | . | . | .  | .  |
| Brush Cuckoo                | <i>Cacomantis variolosus</i>      | .     | . | . | + | . | + | . | . | . | .  | .  |
| Common Koel                 | <i>Eudynamys scolopacea</i>       | .     | . | . | + | . | . | . | . | . | .  | .  |
| Channel-billed Cuckoo       | <i>Scythrops novaehollandiae</i>  | .     | . | . | + | . | . | . | . | . | .  | .  |
| Pheasant Coucal             | <i>Centropus phasianinus</i>      | +     | . | . | + | . | . | + | . | . | .  | .  |
| Barking Owl                 | <i>Ninox connivens</i>            | .     | . | . | . | . | . | . | . | . | .  | .  |
| Southern Boobook            | <i>Ninox novaeseelandiae</i>      | .     | . | . | + | . | + | . | + | . | .  | .  |
| Azure Kingfisher            | <i>Alcedo azurea</i>              | .     | . | . | + | . | . | . | . | . | .  | +  |
| Blue-winged Kookaburra      | <i>Dacelo leachii</i>             | +     | + | + | + | . | + | . | + | . | .  | +  |
| Forest Kingfisher           | <i>Todiramphus macleayii</i>      | .     | . | . | + | . | + | . | + | . | .  | .  |
| Sacred Kingfisher           | <i>Todiramphus sanctus</i>        | .     | + | . | . | . | . | . | . | . | +  | .  |
| Rainbow Bee-eater           | <i>Merops ornatus</i>             | +     | + | + | . | + | . | + | + | + | .  | .  |
| Dollarbird                  | <i>Eurystomus orientalis</i>      | +     | + | + | + | . | + | . | + | . | .  | +  |
| Red-backed Fairy-wren       | <i>Malurus melanocephalus</i>     | .     | . | . | . | . | . | . | . | + | .  | .  |
| Little Friarbird            | <i>Philemon citreogularis</i>     | .     | + | . | . | . | . | . | . | . | .  | .  |
| Blue-faced Honeyeater       | <i>Entomyzon cyanotis</i>         | +     | + | . | . | . | . | . | . | . | .  | .  |
| Singing Honeyeater          | <i>Lichenostomus virescens</i>    | +     | . | . | . | . | . | . | . | . | .  | .  |
| White-gaped Honeyeater      | <i>Lichenostomus unicolor</i>     | +     | . | . | + | . | . | . | . | . | .  | .  |
| White-throated Honeyeater   | <i>Melithreptus albogularis</i>   | .     | . | . | . | . | . | . | . | . | .  | +  |
| Brown Honeyeater            | <i>Lichmera indistincta</i>       | +     | . | . | + | . | . | . | . | . | .  | +  |
| Rufous-throated Honeyeater  | <i>Conopophila rufogularis</i>    | .     | . | . | . | . | . | . | . | . | .  | +  |
| Bar-breasted Honeyeater     | <i>Ramsayornis fasciatus</i>      | .     | . | . | + | . | . | . | . | . | .  | .  |
| Banded Honeyeater           | <i>Certhionyx pectoralis</i>      | +     | . | . | . | . | . | . | . | . | .  | +  |
| Jacky Winter                | <i>Microeca fascinans</i>         | .     | . | . | . | . | . | + | . | . | .  | .  |
| White-browed Robin          | <i>Poecilodryas superciliosa</i>  | .     | . | . | . | . | . | . | . | . | .  | +  |
| Grey-crowned Babbler        | <i>Pomatostomus temporalis</i>    | +     | . | . | . | . | + | + | . | . | +  | .  |
| Rufous Whistler             | <i>Pachycephala rufiventris</i>   | .     | . | . | . | . | . | . | . | . | +  | .  |
| Little Shrike-thrush        | <i>Colluricincla megarrhyncha</i> | .     | . | . | . | . | . | . | . | . | +  | .  |
| Satin Flycatcher            | <i>Myiagra cyanoleuca</i>         | +     | . | . | . | . | . | . | . | . | .  | .  |
| Shinning Flycatcher         | <i>Myiagra alecto</i>             | .     | . | + | + | . | . | . | . | . | .  | .  |
| Restless Flycatcher         | <i>Myiagra inquieta</i>           | .     | + | . | . | . | + | . | + | . | .  | .  |
| Magpie-lark                 | <i>Grallina cyanoleuca</i>        | .     | + | + | + | . | + | + | + | + | .  | .  |
| Northern Fantail            | <i>Rhipidura rufiventris</i>      | .     | . | . | + | . | + | . | . | . | .  | .  |
| Willie Wagtail              | <i>Rhipidura leucophrys</i>       | .     | + | + | . | . | + | . | . | + | +  | .  |
| Spangled Drongo             | <i>Dicrurus bracteatus</i>        | .     | . | . | . | . | . | . | . | . | .  | +  |
| Olive-backed Oriole         | <i>Oriolus sagittatus</i>         | .     | + | . | . | . | . | . | . | . | .  | .  |
| Black-faced Cuckoo-shrike   | <i>Coracina novaehollandiae</i>   | .     | . | . | + | . | . | . | . | + | .  | .  |
| White-bellied Cuckoo-shrike | <i>Coracina papuensis</i>         | .     | . | . | . | . | + | . | . | . | .  | .  |
| White-breasted Woodswallow  | <i>Artamus leucorhynchus</i>      | +     | . | . | . | . | . | . | . | . | .  | .  |
| Black-faced Woodswallow     | <i>Artamus cinereus</i>           | .     | + | . | . | . | . | . | . | . | .  | .  |
| Little Woodswallow          | <i>Artamus minor</i>              | .     | . | . | . | . | + | . | . | . | .  | .  |
| Pied Butcherbird            | <i>Cracticus nigrogularis</i>     | +     | + | + | + | . | + | + | + | . | .  | .  |
| Torresian Crow              | <i>Corvus orru</i>                | +     | + | + | + | . | + | . | + | . | .  | .  |
| Great Bowerbird             | <i>Chlamydera nuchalis</i>        | +     | + | + | . | . | . | . | + | . | .  | +  |
| Double-barred Finch         | <i>Taeniopygia bichenovii</i>     | .     | + | . | + | . | + | . | . | . | .  | +  |
| Long-tailed Finch           | <i>Poephila acuticauda</i>        | .     | . | + | . | . | . | . | . | . | .  | .  |
| Masked Finch                | <i>Poephila personata</i>         | .     | . | + | . | . | . | . | . | . | .  | .  |
| Crimson Finch               | <i>Neochima phaeton</i>           | +     | . | . | + | . | . | . | . | . | .  | .  |
| Mistletoebird               | <i>Dicaeum hirundinaceum</i>      | +     | . | . | + | . | . | . | . | . | .  | .  |

## APPENDIX II. AMPHIBIAN, REPTILE AND MAMMAL SPECIES RECORDED IN KEEP RIVER / SANDY CREEK AREA, OCTOBER 1998

1 = "Bucket Springs", 4-5 Oct.; 2 = Alligator Waterhole, 6 Oct.; 3 = Milligan Lagoon, 7 Oct.; 4 = Augustus Hole, 7-8 Oct.; 5 = Emerald Spring, 8 Oct.; 6 = Keep River / Oakes Creek junction, 9-10 Oct.; 7 = Keep River (old airstrip /swamp), 10 Oct.; 8 = Sandy Creek (billabong), 10 Oct.; 9 = Sandy Creek estuary, 11 Oct.; 10 = Sandy Creek tributary, 11 Oct.; 11 = Keep River at road crossing, 11 Oct.

| Species                   |                                       | Sites |   |   |   |   |   |   |   |   |    |    |
|---------------------------|---------------------------------------|-------|---|---|---|---|---|---|---|---|----|----|
| Common name               | Scientific name                       | 1     | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| AMPHIBIA                  |                                       |       |   |   |   |   |   |   |   |   |    |    |
| Copland's Rock Frog       | <i>Litoria coplandi</i>               | .     | + | . | . | . | . | . | . | . | .  | .  |
| Peter's Frog              | <i>Litoria inermis</i>                | .     | . | . | + | . | . | . | . | . | .  | .  |
| Rockhole Frog             | <i>Litoria meiriana</i>               | .     | . | . | + | . | . | . | . | . | .  | .  |
| Rocket Frog               | <i>Litoria nasuta</i>                 | .     | . | . | + | . | . | . | . | . | .  | .  |
| Pale Frog                 | <i>Litoria pallida</i>                | .     | + | . | + | . | . | . | + | . | .  | .  |
| Roth's Tree-frog          | <i>Litoria rothii</i>                 | +     | . | . | + | . | . | . | + | . | .  | .  |
| Red Tree-frog             | <i>Litoria rubella</i>                | .     | + | . | + | . | . | . | + | . | .  | .  |
| Tornier's Frog            | <i>Litoria tornieri</i>               | +     | . | . | + | . | . | . | . | . | .  | .  |
| Wotjulum Frog             | <i>Litoria wotjulumensis</i>          | +     | . | . | . | . | . | . | . | . | .  | .  |
| Froglet                   | <i>Crinia sp.</i>                     | .     | . | . | + | . | . | . | + | . | .  | .  |
| Ornate Burrowing Frog     | <i>Limnodynastes ornatus</i>          | +     | . | . | + | . | . | . | + | . | .  | .  |
| REPTILIA                  |                                       |       |   |   |   |   |   |   |   |   |    |    |
| Freshwater Crocodile      | <i>Crocodylus johnstoni</i>           | +     | + | . | . | . | . | . | . | . | .  | .  |
| Top-end Dtella            | <i>Gehyra australis</i>               | +     | . | . | . | + | . | . | . | . | .  | .  |
| Bynoe's Prickly Gecko     | <i>Heteronotia binoei</i>             | .     | . | . | . | . | . | . | . | . | .  | .  |
| Northern Two-line Dragon  | <i>Diporiphora bilineata</i>          | +     | . | . | . | . | . | . | . | . | .  | .  |
| Gilbert's Dragon          | <i>Lophognathus gilberti</i>          | .     | . | . | + | . | + | . | + | . | .  | .  |
| Bauxite Rainbow-skink     | <i>Carlia amax</i>                    | +     | + | . | . | + | . | . | . | . | .  | .  |
| Striped Rainbow-skink     | <i>Carlia munda</i>                   | .     | . | . | + | . | . | . | . | . | .  | .  |
| Arboreal Snake-eyed Skink | <i>Cryptoblepharus plagiocephalus</i> | +     | + | . | . | . | . | . | + | . | .  | .  |
| Douglas' Skink            | <i>Glaphyromorphus douglasi</i>       | .     | . | . | . | . | . | + | . | . | .  | .  |
| Merten's Water Monitor    | <i>Varanus mertensi</i>               | .     | . | . | + | + | . | . | . | . | .  | .  |
| Mitchell's Water Monitor  | <i>Varanus mitchelli</i>              | +     | + | . | . | . | . | . | . | . | .  | .  |
| Children's Python         | <i>Liasis childreni</i>               | .     | . | + | . | . | . | . | . | . | .  | .  |
| Common Tree Snake         | <i>Dendrelaphis punctulata</i>        | +     | . | . | . | . | . | . | . | . | .  | .  |
| MAMMALIA                  |                                       |       |   |   |   |   |   |   |   |   |    |    |
| Agile Wallaby             | <i>Macropus agilis</i>                | +     | . | . | . | . | . | . | . | . | .  | +  |
| Short-eared Rock-wallaby  | <i>Petrogale brachyotis</i>           | +     | . | . | . | + | . | . | . | . | .  | .  |
| Grassland Melomys         | <i>Melomys burtoni</i>                | +     | . | . | . | . | . | . | . | . | .  | .  |
| Little Red Flying-fox     | <i>Pteropus scapulatus</i>            | .     | + | . | . | . | . | . | . | . | .  | +  |
| Common Sheath-tail-bat    | <i>Taphozous georgianus</i>           | .     | . | . | . | + | . | . | . | . | .  | .  |

